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Rinne

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[54] **HYDRAULICALLY, PNEUMATICALLY OR MECHANICALLY DRIVEN POWER UNIT**

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[51] **Int. Cl.**[5] **B29C 45/64**

[52] **U.S. Cl.** **425/406**; 92/249; 100/267; 425/450.1

[58] **Field of Search** 425/406, 450.1; 60/533; 92/249; 100/267; 72/465, 57, 63, 433.13

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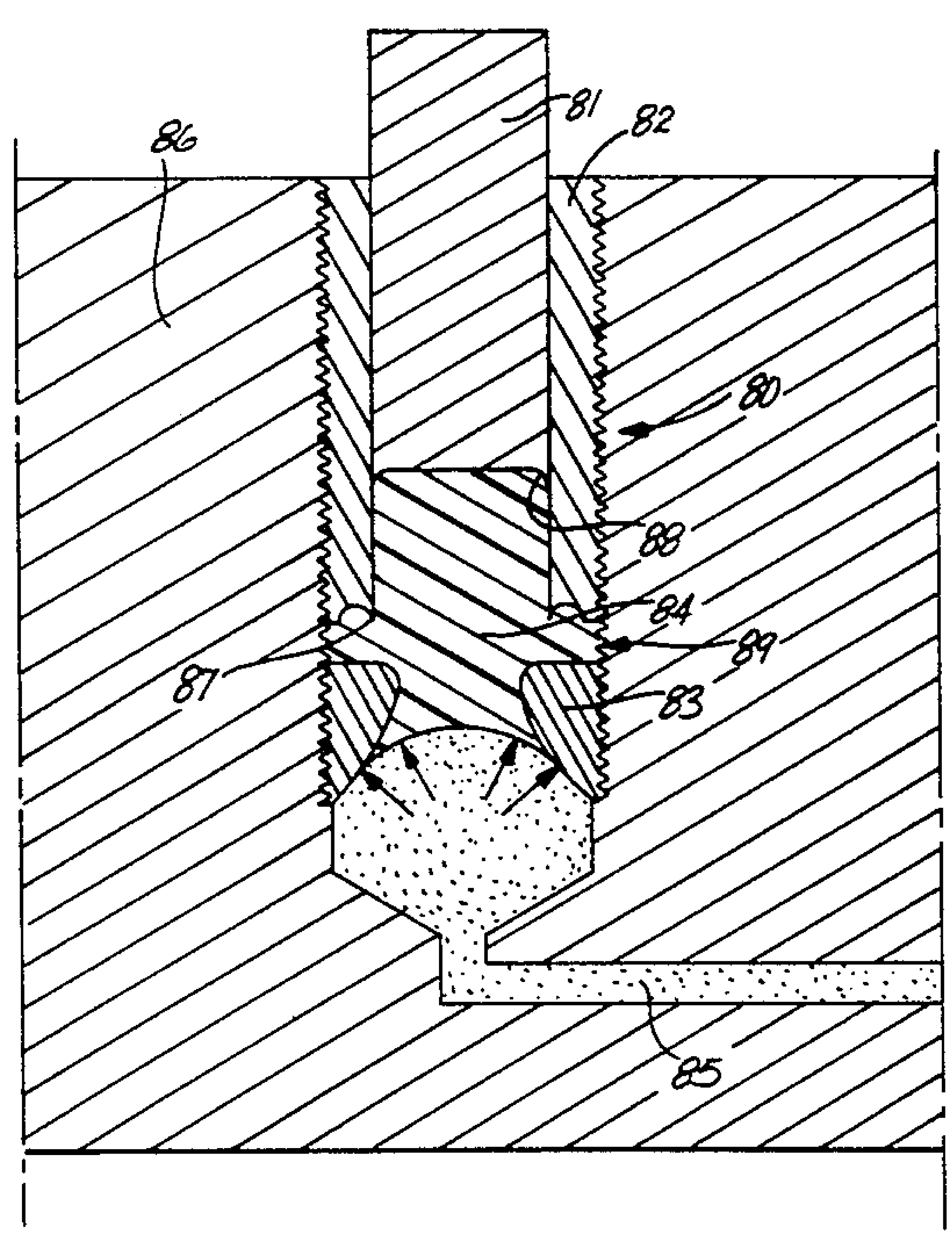
[57] **ABSTRACT**

A hydraulic or pneumatic power unit (1) includes at least one elastomer space (4) for a compressive-force producing/transmitting elastomer (5), the space (4) being formed so as to provide the space (4) with at least one constriction point between pressurizing side and compressing side, and that the elastomer space (4) is filled with elastomer (5) by casting elastomer in situ. Elastomer space (4) is preferably in direct communication with a pressurizing space (2) for a hydraulic fluid (7), the pressurizing space (2) being connected to a pressurizing unit (20). In order to operate the power unit in a die press, particularly for producing wide-bodied compressed articles, the press, including at least two body sections (10*a*) and at least two mold surfaces (8*a*) to be pressed against each other, the pressing of a compressed article is effected in a mold cavity (9) therebetween, and the power unit (1) is adapted to carry at least one mold surface (8*a*) relative to its body section (10*a*) towards the other mold surface (8*b*) through the intermediary of a support layer (13*a*). The support layer (13*a*) is located within the region between the mold surface (8*a*) and the elastomer space and/or press plate (3).

9 Claims, 7 Drawing Sheets



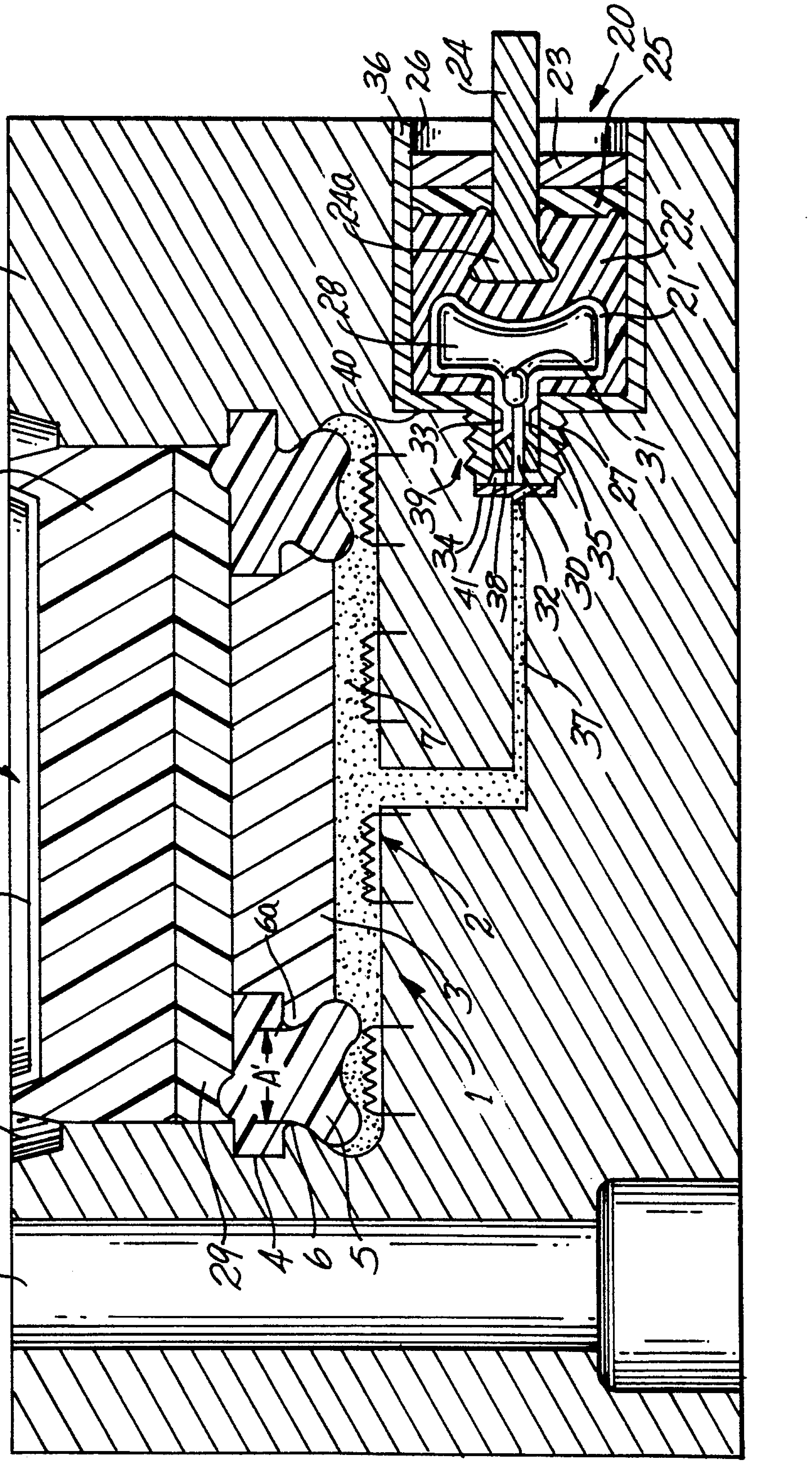

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Fig. 1

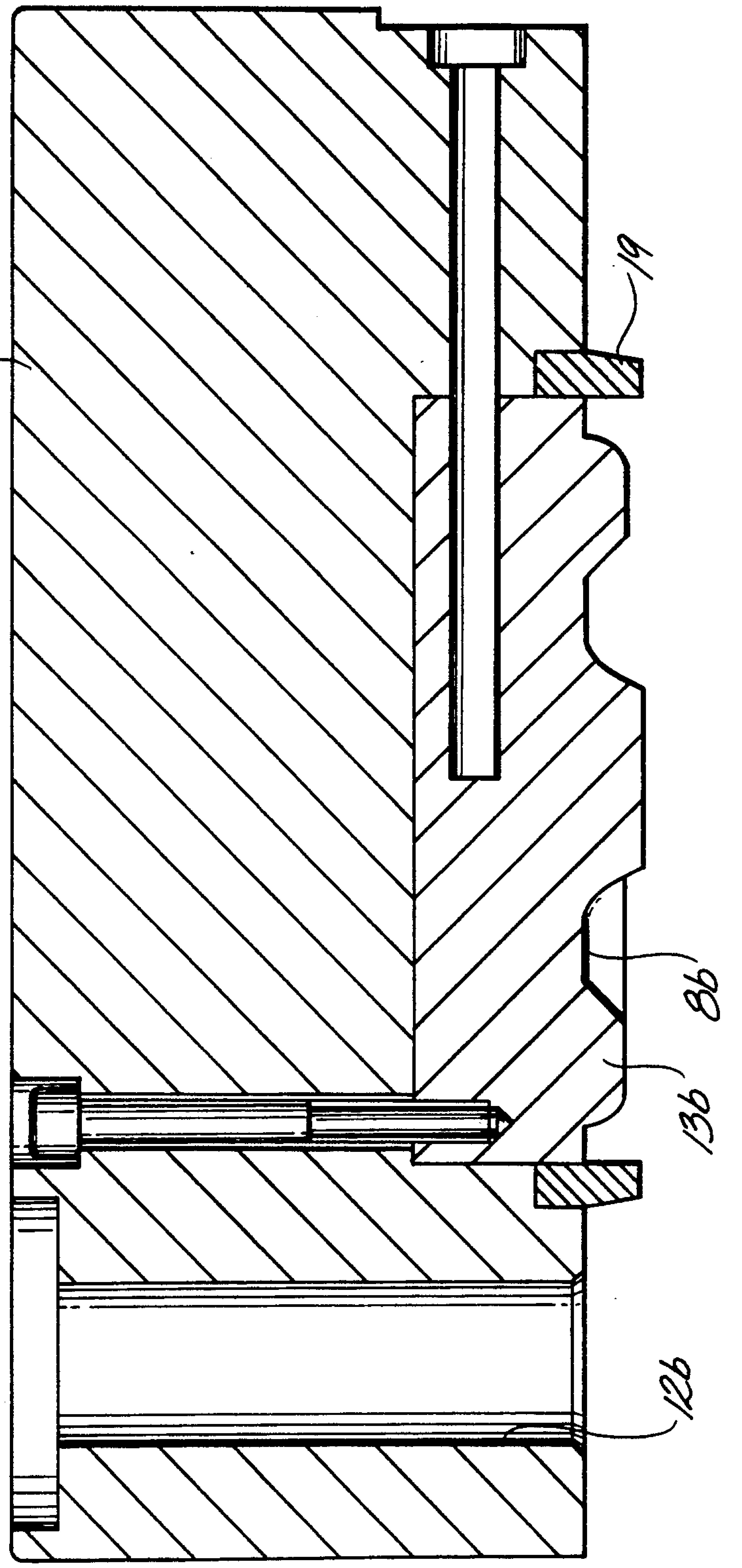


Fig. 2

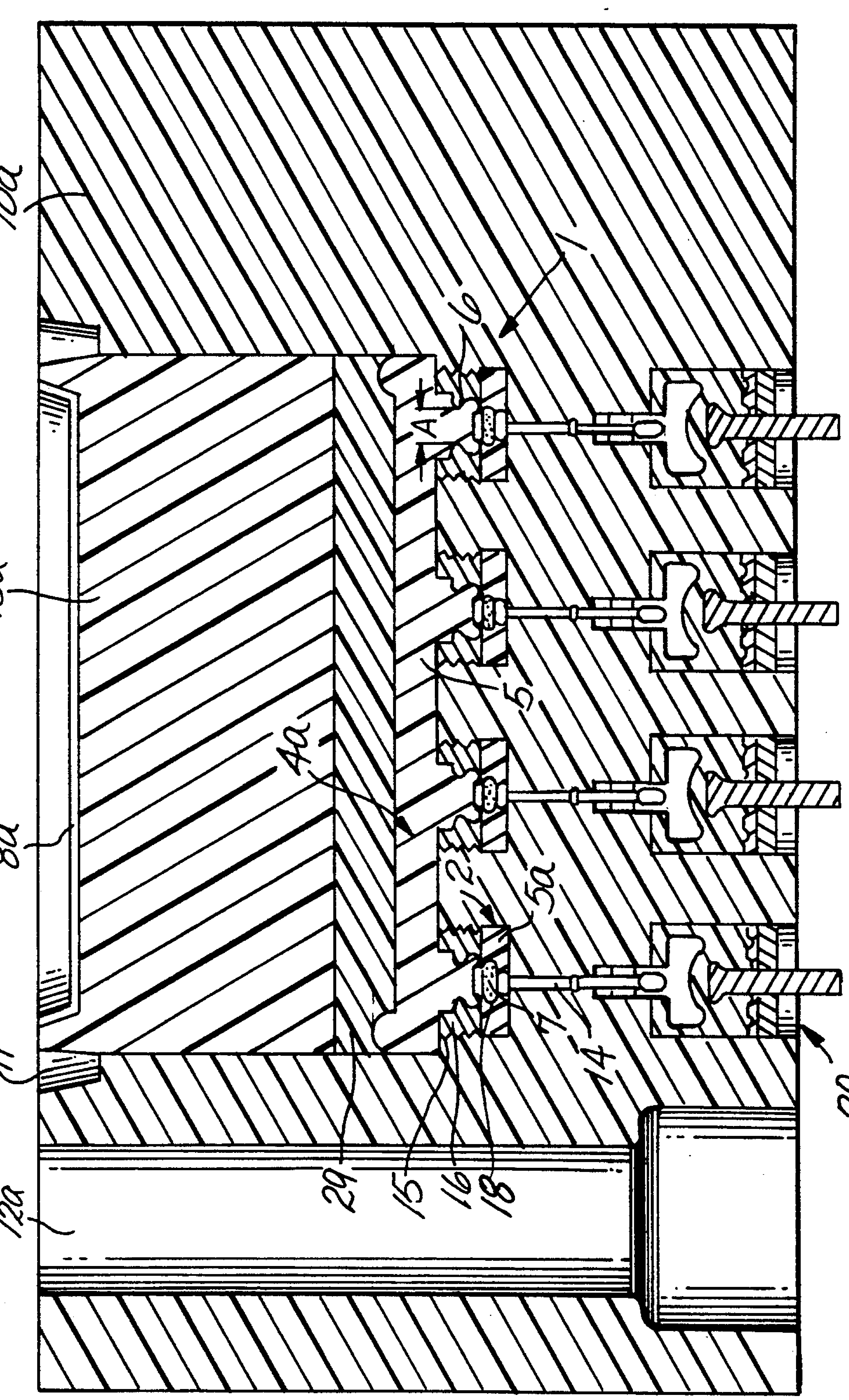


Fig. 3

Fig. 4

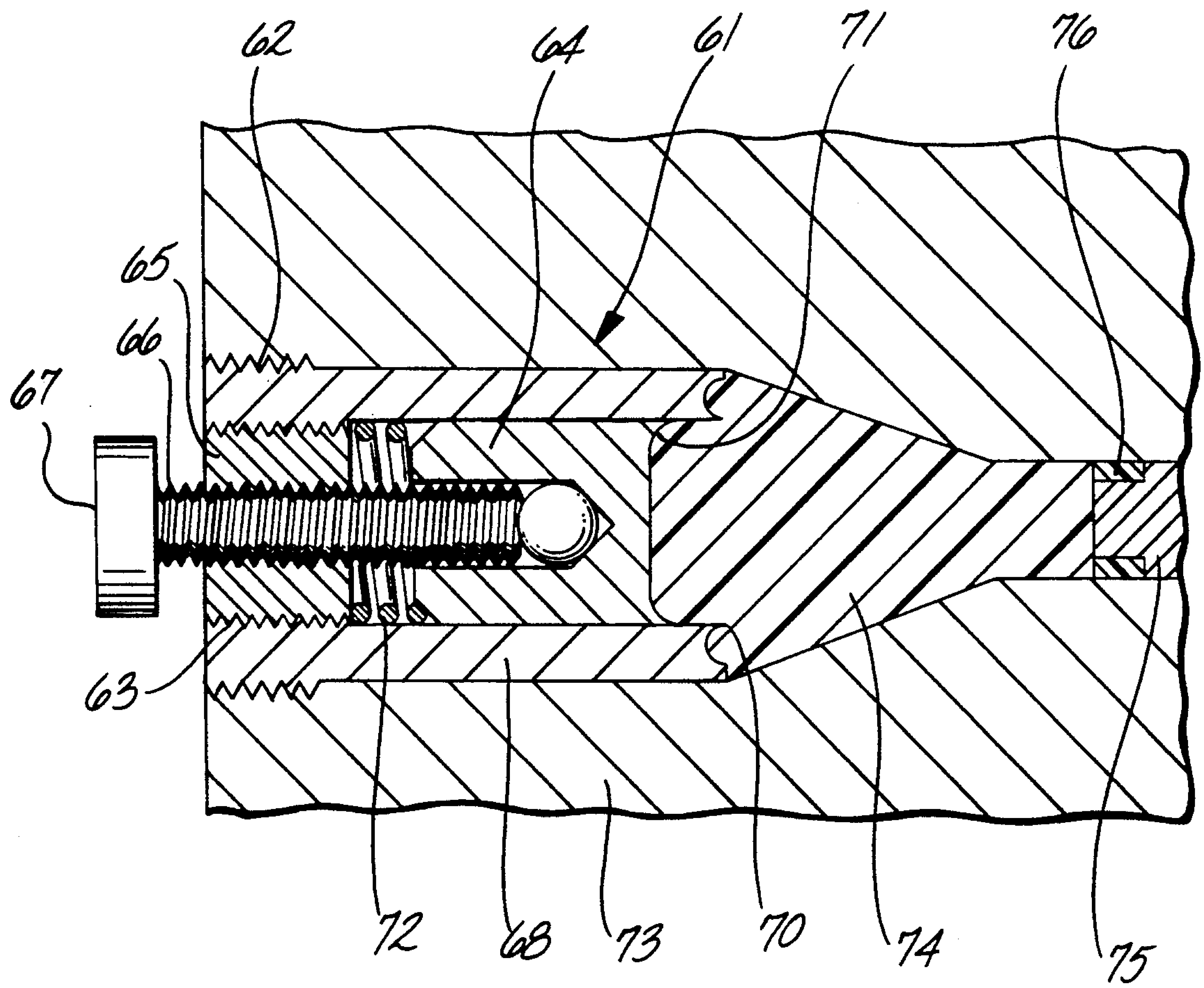


Fig. 5

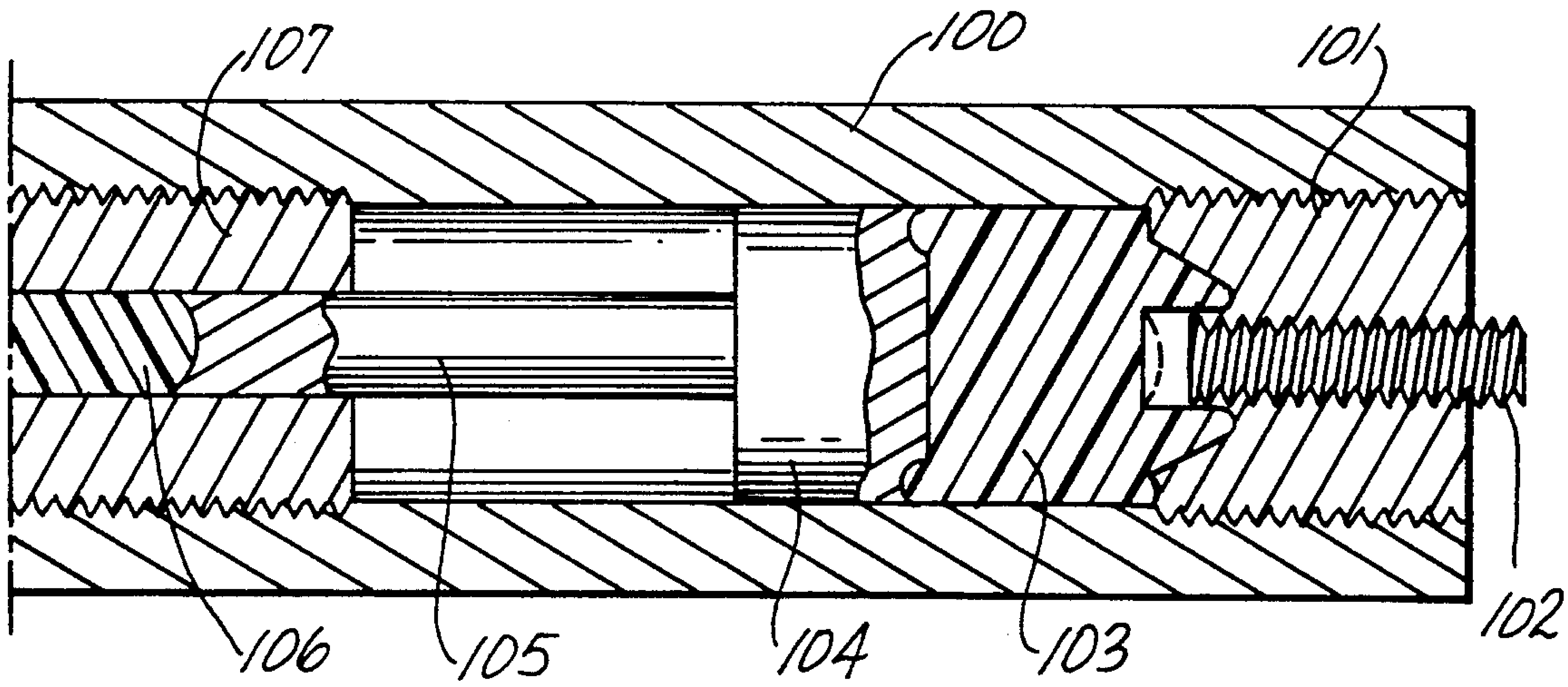


Fig. 6a

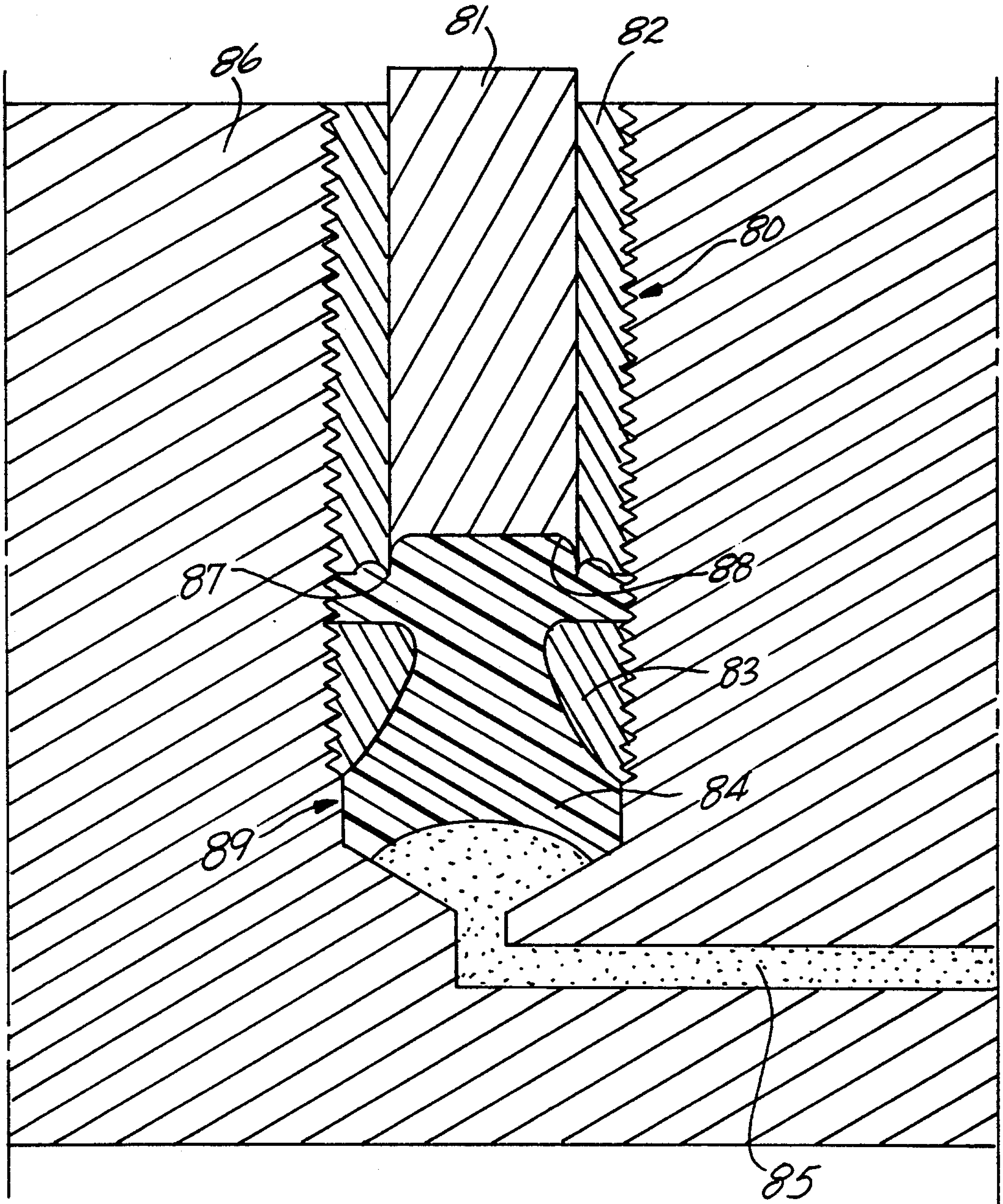
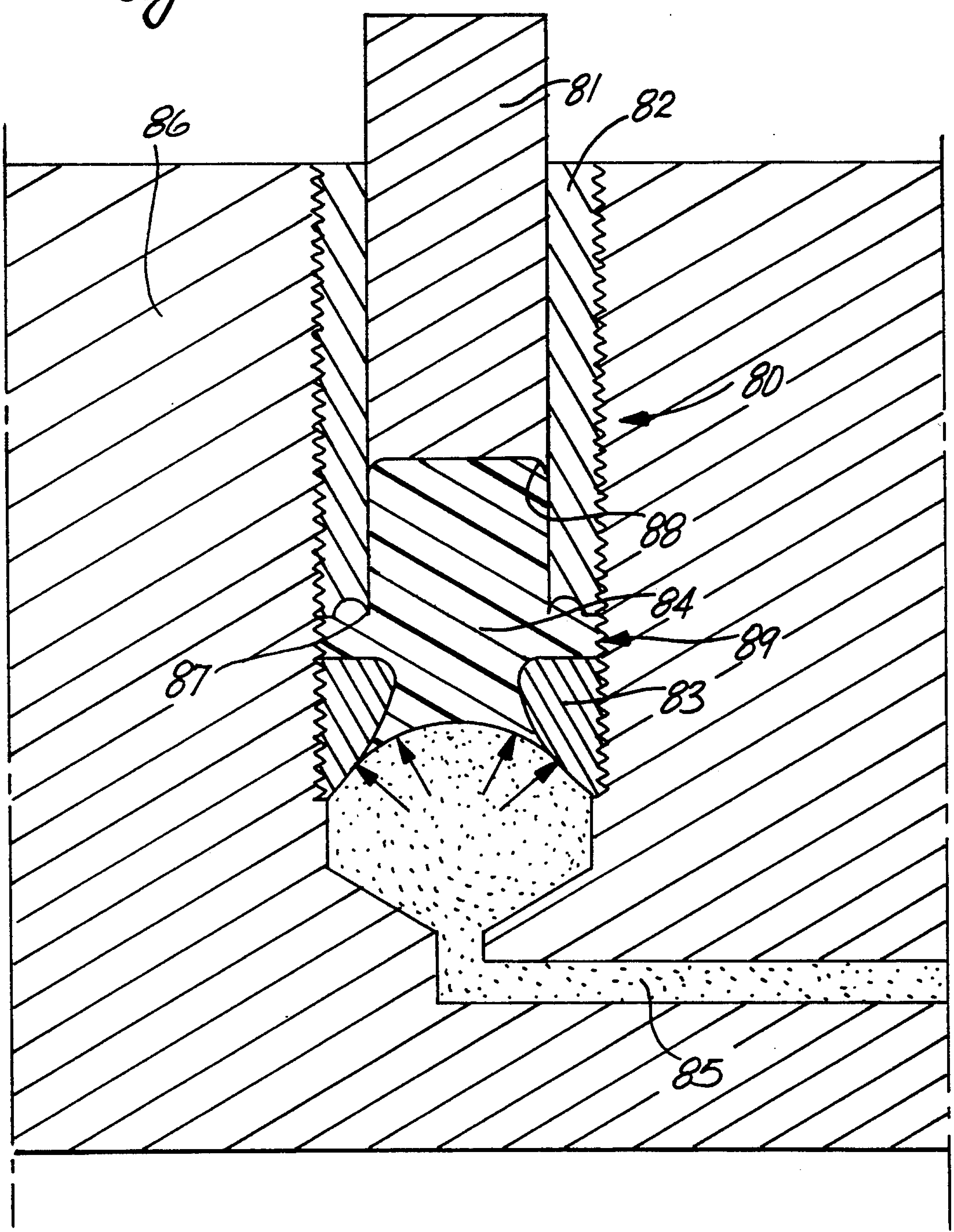


Fig. 66



HYDRAULICALLY, PNEUMATICALLY OR MECHANICALLY DRIVEN POWER UNIT

BACKGROUND OF THE INVENTION

The present invention relates to a hydraulically, pneumatically or "mechanically" drivenpower unit and its application in a die or compression press, particularly for producing wide-bodied compressed articles.

A problem generally encountered in the manufacture of wide-bodied compressed articles is that, in order to produce as uniform a pressure as possible over the entire surface area of a piece to be compressed, the press molds must be relatively rigid and heavy in construction and, in addition, they usually require a plurality of separate pistons for producing a compressive force. One solution for eliminating this problem is described in the Applicant's earlier PCT application WO 89/02986.

SUMMARY OF THE INVENTION

The invention provides a hydraulically, pneumatically or mechanically driven power unit, particularly in a die press, in a manner that the actual molding surfaces can be made as thin and lightweight as possible and, in addition, that a piece to be pressed will be subjected to a pressure as uniform as possible over its entire surface area. In order to achieve this, a power unit of the invention is characterized in that an elastomer space is filled with elastomer by casting elastomer in situ. The application of a power unit of the invention in a die press especially for manufacturing wide-bodied compressed pieces, the press having at least two body sections and at least two molding surfaces to be pressed against each other for effecting the pressing of a compressed piece in a mold cavity therebetween, is characterized in that the power unit is adapted to carry at least one of the mold surfaces relative to its body section towards the other mold surface in a per se known manner through the intermediary of a support layer, said support layer being located in a region between the mold surface and the elastomer space and/or a press plate. The support layer is preferably elastic, made, e.g., of a two-component silicone or polyurethane.

One benefit gained by the application of a power unit of the invention in a die press is the uniform distribution of compression pressure through the intermediary of an elastic support layer over the entire surface area of a piece to be pressed.

Although a power unit of the invention is in this context described in association with a die press, it can of course be applied to many other machine parts and devices, such as couplings, brakes, connectors, sealings etc. One benefit offered by a power unit of the invention is e.g., that the system can be designed as a closed system and the risk of hydraulic oil spill is minimized, especially in "mechanical" application.

In view of the operation of a power unit, an essential feature is e.g., that elastomer does not adhere in the elastomer space and/or to the walls of elastomer passages so as to permit a moderate movement of elastomer in the elastomer space and/or passages under pressure. Elastomer behaves almost as a fluid in a sense that it is incompresssible, a difference from fluid being, however, that elastomer is self-restoring after the action of pressure is stopped. The conducted preliminary tests have indicated that a pressure of over 100 bars, nearly a complete equalization of pressure occurs in a passage having a diameter of about 5 mm and a length of about 500 mm

throughout the entire passage. The non-adherence of elastomer to the walls of passages and elastomer spaces can be enhanced e.g., by means of various lubricants which are compatible with a particularly employed elastomer. Elastomer passages/spaces must usually be designed larger in volume than corresponding fluid passages. However, if necessary, the elastomer can be joined e.g., with a separate sealing layer or with a mechanical piston for a pressurizing medium by using an appropriate medium, such as Chemosil X 5201, available e.g., from Henkel AG (FRG). In addition, the elastomer space must be designed in a manner that elastomer cannot work its way out of the space. This design is effected e.g., in a manner that the region between the pressurizing side and operating (compressing) side of an elasomer space is provided with a section substantially narrower than the rest of the elastomer space whereby, whenever elastomer is subjected to the action of pressure, the pressure action prevailing in elastomer is directed in said narrow section against the walls of elastomer space, preventing elastomer from escaping out of the space. In addition, this narrow section produces a force effect assisting in the return of elastomer at the end of pressure action.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described with reference made to the accompanying drawings, in which:

FIG. **1** illustrates the application of a power unit of the invention in one half-mold of a die press according to a first embodiment;

FIG. **2** shows the other half-mold of a die press according to the embodiment of FIG. **1**;

FIG. **3** illustrates the application of a power unit of the invention in one half-mold of a die press according to a second embodiment;

FIGS. **4–5** illustrate some of the mechanical pressurizing mediums; and

FIGS. **6*a*–6*b*** illustrate another embodiment for a power unit of the invention.

Referring to FIGS. **1** and **2**, a power unit **1** of the invention used in a die press comprises body sections **10*a*** and **10*b*** and two mold surfaces **8*a*** and **8*b*** to be pressed against each other, the mold surfaces providing therebetween a mold cavity **9** for effecting the compression of a molded piece. The faces of mold surfaces **8*a*** and **8*b*** directed away from the mold cavity are further provided with support layers **13*a*** and **13*b***, respectively. Support layer **13*a*** and **13*b*** is preferably made of an elastic material or optionally of metal, wood, cement, foundry sand or the like. In the embodiment of FIG. **2**, support layer **13*b*** is made of the same material as mold surface **8*b*** providing an integral structure therewith. The same way, mold surface **8*a*** can also be made of the same material as its support layer **13*a***. In order to carry mold surface **8*a*** towards the other mold surface **8*b***, the die press employs a hydraulically, pneumatically or mechanically driven power unit **1** for producing a compressive force. As shown in FIG. **1**, the power unit has a cavity space in body section **10*a*** with an elastomer space **4** being formed between a press place **3** and the edge of said cavity space, the space being filled with an elastomer layer **5**. Between elastomer space **4** and the floor of the cavity space is further built a space **2** for hydraulic fluid **7** or compressed air or an elastomer medium producing the compressive force. In the context of this application, the term compressed air includes not just normal air, but also any generally pressurized gas or gas mixture. The edge of press plate 3 and the edge of elastomer space 4 in body section **10***a* are provided with a protrusion **6***a*, **6** in a manner that, in alignment with such protrusions **6***a*, **6**, the elastomer space **4** will be provided with a section or region A substantially narrower than the rest of the space. Elastomer layer **5** is cast in situ in space **4**. This in-situ casting together with narrow region A of space **4** results in a situation that a pressure effect applied to elastomer layer **5** causes the displacement of elastomer layer in elastomer space and the deformation of elastomer, the forces acting in the layer being applied against the walls of press place **3** and elastomer space **4**, thus preventing the removal of elastomer layer **5** from the elastomer space. Between elastomer layer **5** and support layer **13***a* is further provided a sealing member **29**, preferably made of a resilient material harder than elastomer **5**, e.g., of teflon or a suitable metal or harder elastomer. The material used for press plate **3** can be e.g., thermosetting plastic or various metallic materials, e.g., copper.

When the power unit is operated by means of hydraulic oil, the power unit **1** is preferably connected by was of a hydraulic pipe or duct **37** to a hydraulic oil pressurizing unit **20**. The pressurizing unit **20** preferably includes a sleeve-like body section **36** provided with a bottom portion **40** for building a cavity space **26** inside the body section **36**. The bottom portion **40** is provided with a protrusion **39** which is fitted with an external threaded member and extends outwardly of cavity **26**. Protrusion **39** is provided with a hole extending into cavity space **26**, the hole being preferably fitted with an internal flange **41** at the end of protrusion **39** furthest away from cavity **26**. In the cavity space **26** of body section **36** is formed a space **28** for hydraulic fluid **7**, e.g., by means of an elastomer-made membrane **21** and a massive elastomer layer **22**. In order to connect space **28** with duct **37**, the bottom of cavity **26** is provided with a connector **27**, comprising an internal-hole fitted connector tube **30**, one end of which is provided with an enlargement **31** and the other end is provided with a threaded portion **32**. The connector further includes a "bead" portion **33** and a separate sleeve member **34**. Connector **27** is assembled in a manner that the bottom of membrane **21** is provided with a tubing member **35** which is forced on top of the connector pipe enlargement **31** so as to extend beyond said enlargement in longitudinal direction. This is followed by placing the bead portion **33** on top of connector pipe **30** from the end facing threaded portion **32** and by pushing it on top of tubing member **35** into the abutment with enlargement **31**. The bead portion **33** is preferably formed by fitting both ends thereof with internal cones. This is followed by placing sleeve member **34** on top of connector tube **30** from threaded end **32** and by pushing it into the abutment with bead portion **33** in a manner that tubing member **35** remains between bead portion and sleeve member. The end of sleeve member **34** coming against bead portion **33** is preferably designed in its outer surface as a tapered configuration for facilitating the positioning of tubing member **35** between bead **33** and sleeve **34**. Finally, the connector tube **30** is coupled with body section **36** by means of a nut **38** fastened to threaded portion **32** extending through the hole of protrusion **39**, the nut being tightened to a suitable tightness. An elastomer layer **22** surrounds the entire membrane **21** up to connector **27**. The region between layer **22** and the outer surface of body section **36** is further provided with a piston **23**, and between piston **23** and layer **22** is fitted a sealing **25**, made e.g., of teflon or copper. In addition, the unit **20** preferably includes a plunger **24** extending through piston **23** and sealing **25** into elastomer layer **22**. The inner end of plunger **24** is provided with an enlargement **24***a* for an improved adherence to layer **22**. The movement of piston **23** and plunger **24** is effected e.g., by means of conventional hydraulic or pneumatic or mechanical or the like equipment.

Space **28** can also be provided by mounting connector member **27** on body section **36** without a separate membrane **21** or its tubing portion. This is followed by placing in cavity **26** a piece made of e.g., stearine or a like material, serving as a mold for space **28**. This is followed by casting in the cavity an elastomer layer **22** which is maintained under pressure until it is consolidated. Elastomer penetrates under pressure into a gap between the tapered surfaces of bead portion **33** and sleeve member **34** setting in its position. After the setting of elastomer, the piece of stearine making up the cavity **28** is melted by heating, whereby the stearine can be trickled away along the inside hole of connector pipe **30**. Pressurizing unit **20** is preferably connected to a cavity formed in body section **10***a* and substantially matching the outer diameter of body section **36**, the bottom of said cavity being provided with an internally threaded hole for protrusion **39**. The pressurizing unit is fitted in position by screwing protrusion **39** into a threaded hole in the bottom of the cavity of body section **10***a*, the threaded hole being sealable by conventional means, e.g., by a teflon strip, whereby the threaded portion **32** of connector pipe **30** in connector **27**, the threaded portion being preferably fitted with a tapered head, will be placed in a hydraulic tube or duct **37** formed in body section **10***a*. By means of this arrangement it is possible to design the assembly made up by pressurizing medium and power unit as a closed system, so that hydraulic oil will be in a channel confined by massive elastomer layers with practically no spilling hazard existing.

In the embodiment of FIG. **3**, the space **4***a* of body section **10***a* is filled with elastomer **5**, the compressive force thereon being produced by means of a plurality of power units **1** provided on the bottom of the cavity space. Power units **1** are provided by drilling holes **14** in the bottom of the cavity for a pressure medium. The upper end of holes **14** is provided with a wider threaded hole **15** fitted with a sleeve member **16** whose inner face is provided with a protrusion **6** the same way as the edges of press plate **3** and cavity shown in FIG. **1**. Sleeve member **16** and the cavity are filled with elastomer **5** (e.g., two-component silicone). In addition, a space **2** between sleeve member **16** and the bottom of threaded hole **15** is filled with elastomer **5***a* with a tubing **18** embedded therein. Tubing **18** is connected to pressure medium hole **14** which is in communication with pressurizing unit **20**. The illustrated hydraulic-oil pressurizing unit can also be replaced with any of the mechanical pressurizing means shown in FIGS. **4–7**, wherein the pressure medium is elastomer. In order to seal the mold cavity, the body section **10***a* is provided with a sealing **19** which, with the die press in closed position, is placed in a recess **11** formed in body section **10***a*, thus extending over the gap between body sections **10***a* and **10***b*. The body section **10***b* can be further provided with an elastic rim layer for a possible replacement of support layer **13***b* of mold surface **8***b*.

The body sections **10***a* and **10***b* of a die press can be closed against each other by means of conventional presses and by using as fasteners e.g., mechanical clamping means, e.g., clamping bolts fitted in fixing holes **12***a* and **12***b*. In addition, the closing movement can be effected by using a power unit similar to that used for the displacement of mold surface **8***b*. A die press of the invention can also e further used for the manufacture of a mold, preferably by using foundry sand as support layer **13***a*.

The elastomer space can also be designed in a manner that the space is shaped substantially as a truncated cone, the larger base of such cone being preferably located on the pressurizing side, while the smaller base lies on the compression side (on the side of a mold section). the smaller base has preferably a diameter which is approximately 1/10–½ of that of the larger base. Most conveniently, the smaller base has a diameter which is approximately ⅓ of that of the larger base.

Providing the elastomer space with a constriction point is essential in view of preventing the escape of elastomer from the space without the vulcanization of elastomer to the edges of the space. In addition, the constriction point serves to produce a force restoring elastomer **5**, **5***a* upon removal of the action of pressure.

FIGS. **4–5** illustrates a few embodiments for mechanical pressurizing means employed in power units of the invention. In this context, a mechanical pressurizing means or medium refers to the fact that the pressurizing means applies pressure directly to an elastomer layer or elastomer medium. This type of mechanical pressurizing means can also be designed e.g., by using hydraulic oil between the elastomer medium and the actual power-unit operating elastomer layer, in which case the assembly can be referred to as a mechanical/ hydraulic drive.

In the embodiment of FIG. **4**, a pressure means **61** comprises an outer piston member **68** provided with a threaded portion **62** and having an inner piston **64** fitted inside. The inner piston **64** is operated e.g., by means of a screw member **66**, the screw member being connected through the intermediary of a spacer block **65** with a threading **63** to outer piston **68**. Between spacer block **65** and inner piston **64** is further fitted a spring **72** which compensates for variations of the volume/pressure of elastomer induced by variations of temperature. Such volume/pressure control can also be effected e.g., by controlling temperature, whereby a spring **72** can be omitted.

Such a temperature control **72***a* is shown schematically in FIG. **1**.

The screw member **66** is further provided with an external driving head **67**. The inner piston can also be operated e.g., by means of an eccentric or some other per se known mechanical component. The outer piston member **68** is used for fastening the pressure means **61**, e.g., to the body section **73** of a piece to be sealed, and it also serves as an initial pressure adjuster. The actual pressurization is performed by inner piston **64**. In the case shown in FIG. **4**, inner piston **64** acts on an elastomer layer **74** which, in turn, displaces a piston **75**. Piston **75** is fitted with a sealing **76**, made, e.g., of teflon, copper or a like sealing material. Piston **75** further acts on a pressurizing means or medium (hydraulic oil or elastomer), which medium is in communication with space **2** e.g., in the embodiment of FIG. **1**, for pressurizing the elastomer **5** operating said power unit. Thus, a pressurizing means **61** replaces a pressurizing unit **20** shown in FIG. **1**. Piston **75**, along with its sealing **76**, can also be omitted, whereby elastomer **74** is in direct communication e.g., with said space **2**. The frontal surface of outer piston **68** facing elastomer space or medium **74** is preferably provided with a groove **69**, the inner edge of outer piston **68** being formed with a lip portion **70** for preventing the passage of elastomer in between inner piston **64** and the internal surface of outer piston **68** as the inner piston **64** extends beyond the frontal surface of outer piston **68**. The inner piston **64** is provided with a corresponding lip portion **71** for preventing the passage of elastomer in between inner and outer pistons as piston **64** is positioned inside said outer piston **68**. Lip portion **71** can also be provided as a separate sealing which is attached to inner piston **64**. Accordingly, lip portion **70** can be formed by means of a separate sealing ring which, in turn, is attached to outer piston **68**. For a more uniform distribution of the pressure applied to elastomer, the elastomer layer **74** is preferably given a triangular shape. Alternatively, inner piston **64** can be made e.g., wedge-shaped at the end thereof facing elastomer.

FIG. **5** illustrates a solution with a plurality of various-sized pistons successively connected to each other. A spacer block **101** is fastened to a body section **100** e.g., by means of a threaded coupling, the spacer block being provided with a first piston or rod **102**. The first piston acts on a first elastomer layer **103** which transmits the pressure to a second piston **104** having a surface area substantially larger than that of the first piston **102**. The surface of second piston **104** facing away from first elastomer layer **103** is provided with a third piston **105** having a surface area substantially smaller than that of the second piston **104**. The third piston **105** produces an increased pressure on a second elastomer layer **106** inside an inner tube **107**, the piston combination or assembly serving as a pressure booster. The magnitude of boosting depends on the ratio of the piston surface areas. By contrast, the second elastomer space **106** is, e.g., in the embodiment of FIG. **1**, in communication with space **27**, instead of hydraulic oil for pressurizing elastomer layer **5**.

FIGS. **6***a* and **6***b* illustrate one power unit of the invention comprising separate components to be mounted on a body section. FIG. **6***a* shows the power unit in its initial position, and FIG. **6***b* shows the power unit as subjected to the action of pressure. According to the figures, a power unit **80** comprises an externally threaded cylindrical member **82** with an inner piston **81** adapted to be axially movable thereinside. The power unit further includes an externally threaded constriction block **83**. When assembling the power unit, a body section **86** is provided with cylindrical member **82** and a threaded hole matching the male thread of constriction block **83**, the bottom of said hole being provided with a duct for hydraulic oil **85**. Assembling the power unit is effected in a manner that constriction block **83** is threaded to a desired location in the threaded hole of body section **86** followed by screwing cylindrical member **82** into the same threaded hole. Constriction block **83** and cylindrical member **82** are preferably placed in the threaded hole in a manner that the opposing frontal surfaces thereof are spaced from each other in axial direction. The installation of constriction block **83** and cylindrical member **82** is followed by casting elastomer **87***a* in an elastomer space **87** which is defined by the bottom of the threaded hole of body section **86**, as well as by constriction block **83** and cylindrical member **82**. The casting of elastomer layer is effected e.g., by placing on the bottom of the threaded hole a wax plug for preventing the passage of elastomer during the casting operation into the duct of hydraulic oil **85**. During its setting, the elastomer layer **87***a* is compressed with an appropriate force by means of inner piston **81**. The frontal surface of inner piston **81** coming against the elastomer layer is preferably treated with a binder which effects the vulcanization of elastomer layer fixedly to inner piston **81**. After the setting of elastomer, the wax plug can be removed e.g., through the hydraulic-oil duct by vaporization or by using suitable chemicals. This is followed by filling the hydraulic-oil duct with hydraulic oil **85**, whose pressurization can be effected, e.g., by using a pressurizing unit **20** shown in FIG. **1** or a pressurizing means **61** shown in FIG. **4**. FIG. **6***b* illustrates the displacement of elastomer under the action of pressure. An essential feature in the design of constriction block ;**83** is to bring the forces prevailing in elastomer to apply against the walls of constriction block **83** in a manner that elastomer is not capable of moving in its entire quantity over the narrow part of constriction block **83**. As the displacement of elastomer over the narrow part is prevented, hydraulic oil **85** is not able to leak out of the assembly between the walls of elastomer layer **87***a* and the elastomer space. In addition, this constriction point produces a force returning elastomer to its original position upon the removal of pressure effect.

It is, of course, possible that a plurality of power units shown in FIGS. **6***a* and **6***b* be mounted on the same body section for moving, in addition to e.g., a die press, various punching means or the like for producing holes, cavities or the like in press pieces. A number of power units can also be combined with each other e.g., for transmitting a force from one place to another.

I claim:

1. A hydraulically, pneumatically or mechanically driven power unit, said power unit comprising:

means for forming at least one elastomer first space for a compressive force producing/transmitting elastomer and a pressurizing second space for a pressure medium, said first space having a pressurizing side and a compressing side and at least one constriction point within a region between the pressurizing side and the compressing side, wherein said first space is filled with elastomer by casting the elastomer in situ, said constriction point being formed by providing an edge of the means for forming the first space with an inward directed first protrusion and by providing a press plate in said first space substantially in a central area thereof, an edge of said press plate being fitted with a second protrusion substantially facing said first protrusion, and wherein the pressurizing second space is disposed directly in communication with the first space, said second space being in further communication with a pressurizing unit.

2. A power unit as set forth in claim **1**, wherein said elastomer comprises two-component silicone or two-component polyurethane.

3. A power unit as set forth in claim **1**, wherein said pressurizing second space and said pressurizing unit are arranged as a closed system, wherein said pressurizing unit comprises a third space defined therein for the pressure medium, said third space being defined by a membrane and elastomer layer, whereby the pressure medium is in a channel confined by the elastomer layer at one end of said channel and the press plate at the other end of said channel.

4. A power unit as set forth in claim **1**, wherein said pressurizing unit comprises means for controlling the temperature of the elastomer.

5. In a die press for producing wide-bodied compressed articles, said press comprising at least two body sections and at least two mold surfaces to be pressed against each other, the pressing of a compressed article being effected in a mold cavity therebetween, and said press having a hydraulically, pneumatically or mechanically driven power unit, the improvement wherein said power unit moves at least one of the mold surfaces towards the other of the mold surfaces through the intermediary of a support layer, the power unit having at least one elastomer first space defined therein for a compressive force producing/transmitting elastomer, said first space having at least one constriction point within a region between a pressurizing side and a compressing side of the first space, wherein said first space is filled with elastomer by casting the elastomer in situ, said constriction point being formed by providing the edge of the first space with an inward directed first protrusion and by providing said first space substantially in a central area thereof with a press plate, whose edge is fitted with a second protrusion substantially facing said first protrusion, and wherein a pressurizing second space for a pressure medium is formed in the power unit directly in communication with the first space, said second space being in further communication with a pressurizing unit, said support layer being laid within the region between the at least one mold surface and the first space and the press plate.

6. A die press as set forth in claim **5**, wherein said support layer comprises one of the following material: an elastic two-component silicone, foundry sand, concrete, or metal.

7. A die press as set forth in claim **5**, wherein between said support layer and first space and press plate a sealing layer is disposed, said sealing layer comprising one of the following materials: a metal, or a resilient material harder than the elastomer in the first space.

8. A die press as set forth in claim **5**, wherein said mold cavity is sealed at its rim portion with a seal which extends over a gap between body sections when said die press is in a closed position.

9. A hydraulically driven power unit, said power unit comprising:

a body section having a threaded hole, the bottom of said hole being provided with a duct for hydraulic oil, an externally threaded constriction block threaded to a desired location in said hole close to the bottom of said hole, and an externally threaded cylindrical member threaded in said hole spaced from said constriction block in an axial direction, said cylindrical member being provided with an inner piston mounted for axial movement therein, wherein the bottom of said hole, the constriction block, and the cylindrical member define an elastomer space for an in situ cast elastomer, said in situ cast elastomer being disposed in said elastomer space, and said duct is filled with hydraulic oil, whose pressurization is effected by using a pressurizing unit.

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